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A CINEFLUOROGRAPHIC UNIT

*Subtask under X-ray and Photographic Techniques, USAMRL Project No. 6-59-08-012, Subtask, Cineradiographic Techniques.

RESEARCH AND DEVELOPMENT DIVISION
OFFICE OF THE SURGEON GENERAL
DEPARTMENT OF THE ARMY

REPORT NO. 333

A CINEFLUOROGRAPHIC UNIT

by

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Report No. 333
Project No. 6-59-08-012
Subtask USAMRL S-1
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ABSTRACT

A CINEFLUOROGRAPHIC UNIT

OBJECT

To improve a cinefluorographic unit.

RESULTS AND CONCLUSIONS

A unit for use in cinefluorographic studies is described. Pulsed x-rays are obtained by the controlled firing of two thyratron tubes (placed in primary circuit of x-ray generator) by an electronic triggering circuit incorporated between camera and primary circuit. Synchronization between camera and triggering mechanism was required to obtain good quality cinefluorographs.

RECOMMENDATION

It is recommended that studies be performed with this unit to obtain and evaluate cinefluorographs of complex portions of the body. In addition, the possibility of color cinefluorography and a portable type cinefluorography unit should be considered and investigated.

Submitted 23 December 1957 by:

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A CINEFLUOROGRAPHIC UNIT

I. INTRODUCTION

Since the discovery of x-rays by Roentgen in 1895 one of the more important goals of the radiographer has been the development of x-ray motion pictures. During the last decade much research has been done and many new techniques and instruments have been developed (1-6). Chisholm (7) developed this particular unit at USAMRL; however, cineradiographs obtained were not of equal density or clarity.

Reynolds (8), Michaelis (9), and Weinberg (11) have shown that there are many techniques and refinements of cinefluorographical methods. Miller (10) has shown the application of cinefluorography to determine or follow the first stages of swallowing.

Researchers in this field have used terminology pertaining to their specific method of obtaining x-ray motion pictures. A few of the terms that are used, and may be used interchangeably, are indirect cineradiography, indirect cineroentgenography, and cinefluorography; however, the end result is the same. In this report the term cinefluorography is used and indicates a means by which one can record fast moving or complicated portions of the body using x-rays, a fluorescent screen, and a cine camera. The projected x-ray image on the fluorescent screen is photographed with the cine camera.

X-rays are not needed during the pull-down cycle of the camera; that is, during film transport. Therefore, if a conventional diagnostic x-ray unit is used, the possibility of wasted x-rays and overexposure to the patient arises. With this in mind, it should be readily understood that some means must be used to interrupt or cut-off the x-rays during this period of film transport. This having been of primary importance the problem also arises of synchronization of camera and unit.

In this article a cinefluorographic unit is described.

II. EXPERIMENTAL

The apparatus for cinefluorography consists of the following component parts:

1. A Bell and Howell standard 35 mm camera equipped with an Eastman Kodak Fluoro Ektar lens (Fig. 1).

2. A triggering mechanism with two General Electric Thyratron (GL-5855) tubes (Fig. 3).

3. A Patterson E-2 intensifying screen.

4. A General Electric control panel with a full wave 200 ma high voltage generator.

5. A Machlett Super Dynamax x-ray tube with focal spots of 1 and 2 mm.

One millimeter squares inked onto the face of the screen provided a means of recording measurements from the cinefluorographs and also aided in focusing the lens.

The motor used to operate the camera is of the synchronous type and provides a camera speed of twenty-four frames per second. All tests were made using this speed.

The camera is equipped with two magazines, each holding 200 feet of film, possibly allowing an experiment or operation to continue without the necessity of reloading either magazine. The exposed film was processed in a semi-automatic machine similar to the one previously used by Shemesh (11). As much as 200 feet of film can be processed through the machine at one time.

Kodak D 11 developer was used to process the Eastman Kodak Linagraph ortho-negative film because of the high contrast and fine grain. D-19 can also be used but results in a sacrifice of detail, due to the increase of speed and contrast of the developer. It is necessary for the camera to have register pins and an efficient shuttle because of the synchronization needed between the camera and trigger unit. The lens has been enclosed in a bellows which is connected to the fluorescent screen; therefore, being light tight. With the aid of an ultraviolet lamp directed onto the face of the fluorescent screen and a piece of ground glass in place of the film in the shuttle, one can view the screen and focus the lens. Because the materials that make up the fluorescent screen become discolored as a result of repeated exposures to ultraviolet rays, two screens were employed, one for focusing and one for use in the cinefluorographic studies.

III. RESULTS

The cinefluorographs obtained from this unit are of good quality (Fig. 6 and 7). Film strips were made at each cam setting to determine

the presence or absence of frame lag; thereby, determining the synchronization between camera and trigger mechanism. Figure 6 reveals strip cinefluorographs demonstrating each cam setting. Operating the unit at 100 ma and 78 kv for 20 sec with an added filtration of 1/2 mm of aluminum and a tube to screen distance of 35 in., a maximum dose of 12 r was recorded (as measured by a Victoreen chamber lying on the fluorescent screen). A patient could be examined under these conditions for approximately 25 sec before obtaining a dose of 15 r.

IV. DISCUSSION

A Bell and Howell standard 35 mm camera was altered to receive a special aluminum plate fabricated to fit in place of the original turret mechanism. The lens mount was positioned on this plate. A portion of the camera adjacent and slightly forward of the film gate was machined to enable the aluminum plate to fit down into the turret housing close to the film advancing mechanism (Fig. 2). The lens mount accepts a Kodak Fluoro Ektar lens with an aperture of f/0.75 and a focal length of 110 mm (Fig. 1).

The mount also houses a set of automotive points electrically connected to the assembly and in turn grounded (Fig. 2). Activating the set of points is a cam (Fig. 2), which holds the points open approximately one-half of one revolution. The cam has six settings which can be changed to produce or prevent a frame lag, the frame being in position approximately 180°, irrespective of this setting. As can be seen in Figure 6, there is one position, possibly 2, of the cam that renders film images of good quality.

The trigger circuit with General Electric thyratron tubes (Fig. 5) represents the pulsing apparatus in the unit. The thyratron tubes act as a switch in the primary circuit of the x-ray generator, with the trigger unit controlling the firing of the thyratron tube. Each thyratron fires twenty-four half cycles per second, (one operating on positive half cycles, and the other on negative half cycles).

Once the thyratron has started to fire, it will continue firing until the end of that particular half cycle. The trigger unit permits excitation of the thyratron only at the time the camera points open. This provides a closed primary circuit of the x-ray generator resulting in high voltage applied to the x-ray tube. It is possible to operate only one thyratron tube by shutting off one half of the trigger circuit; thereby, rendering the effect of halfwave rectification resulting in one-half the radiation of a full wave rectified unit. This condition could be used

when performing experiments with small animals, where the penetration with both tubes firing would be too great even with the lowest factors available on the control panel.

The General Electric GL-5855 thyratron tube was selected for use because of its ability to operate at maximum ratings over a wide temperature range, and its quick-heating cathode. Only one minute is required for the cathode to reach operating temperature.

V. CONCLUSIONS

A unit for use in cinefluorographic studies is described. Pulsed x-rays are obtained by the controlled firing of two thyratron tubes (placed in primary circuit of x-ray generator) by an electronic triggering circuit incorporated between camera and primary circuit. Synchronization between camera and triggering mechanism was required to obtain good quality cinefluorographs.

VI. RECOMMENDATIONS

Studies should be performed with this unit to obtain and evaluate cinefluorographs of complex fixed and moving portions of the body.

There is need for perfecting a faster preset camera focusing for different camera-screen distances.

The possibility of color cinefluorography should be investigated.

The possibility of a portable-type cinefluorographic unit should be considered.

There is need for finding a film more sensitive to the particular wave length emitted from the Patterson E-2 fluorescent screen.

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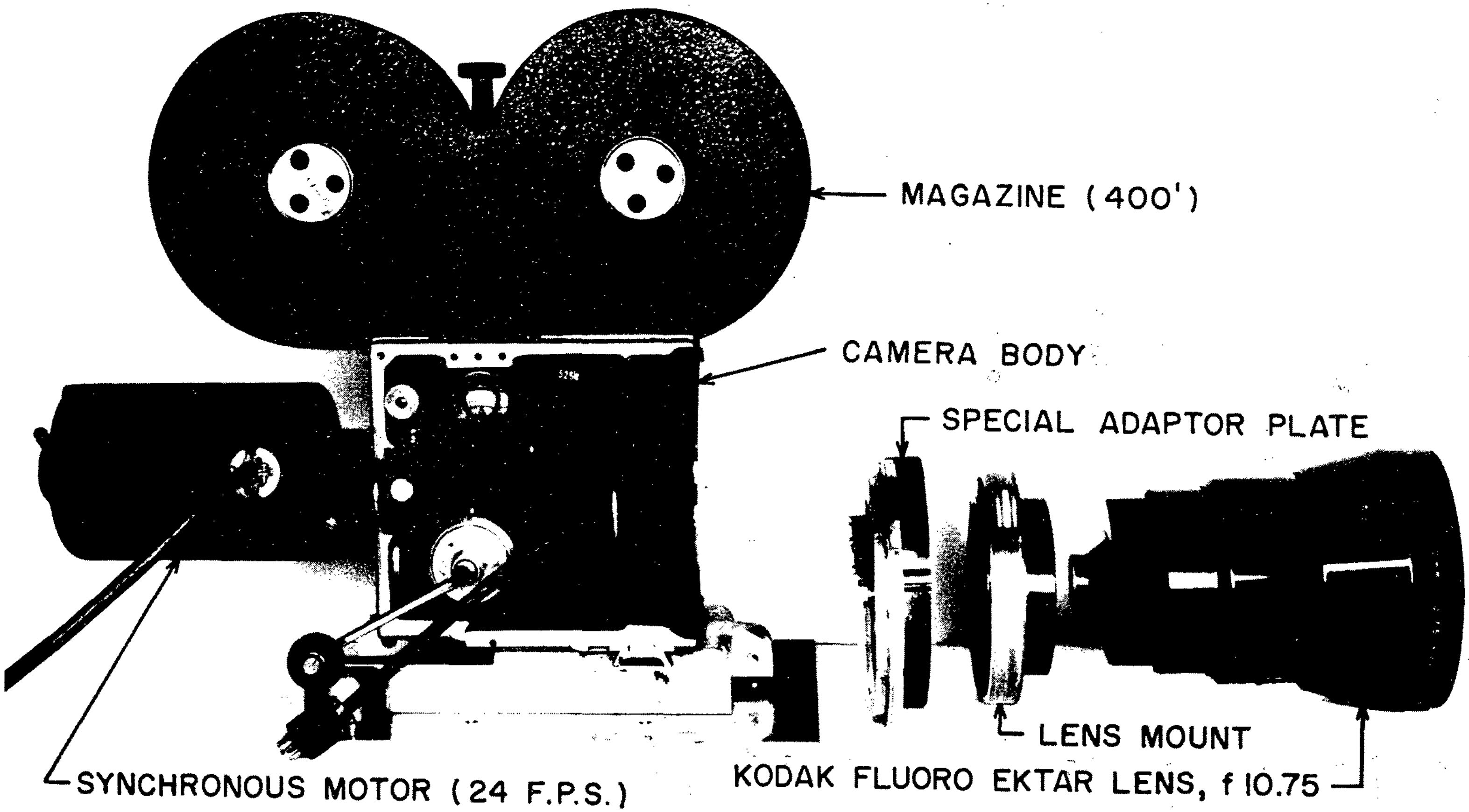

Fig. 1. Camera assembly.

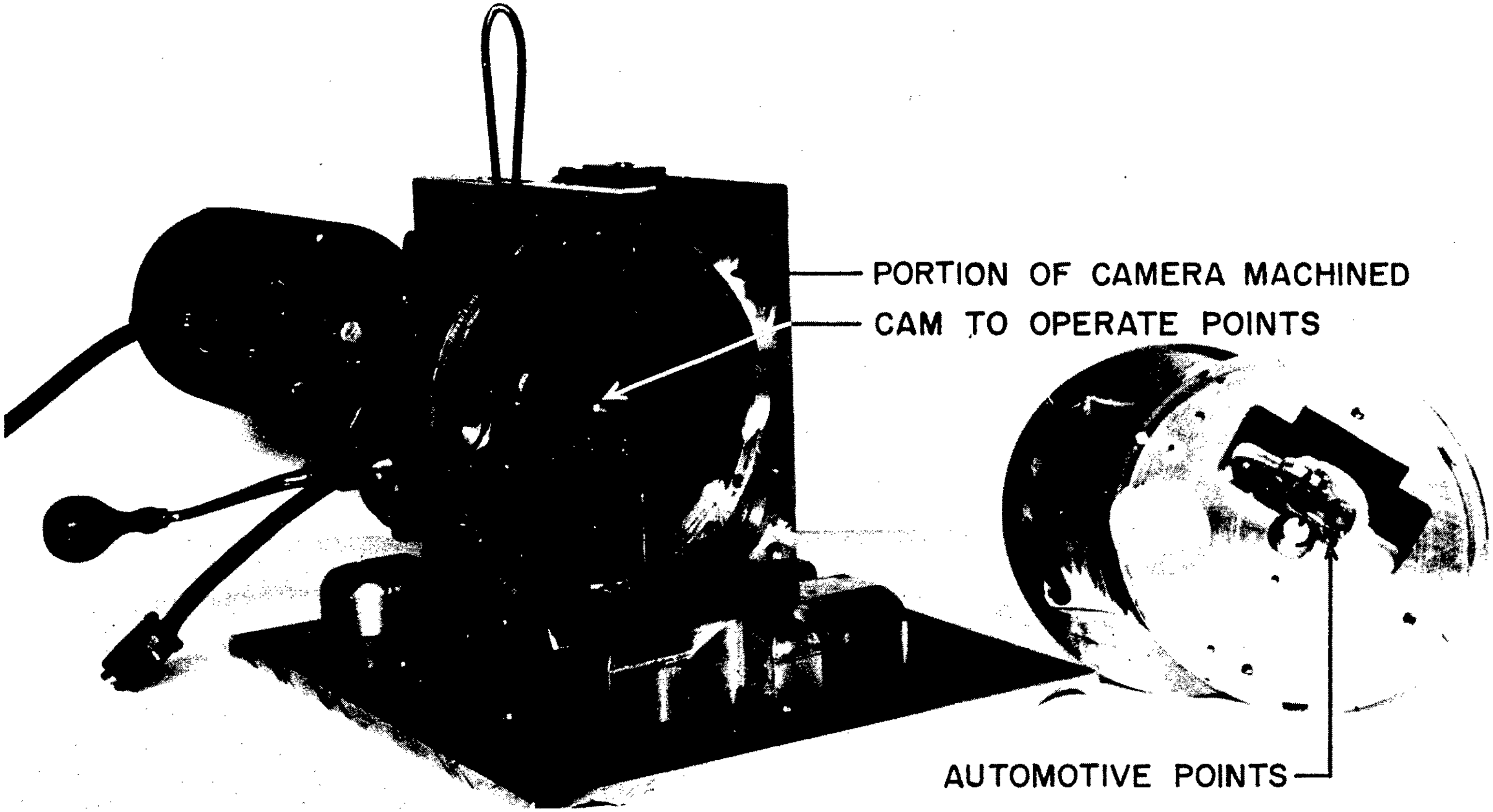

Fig. 2. Close-up of camera with special plate.

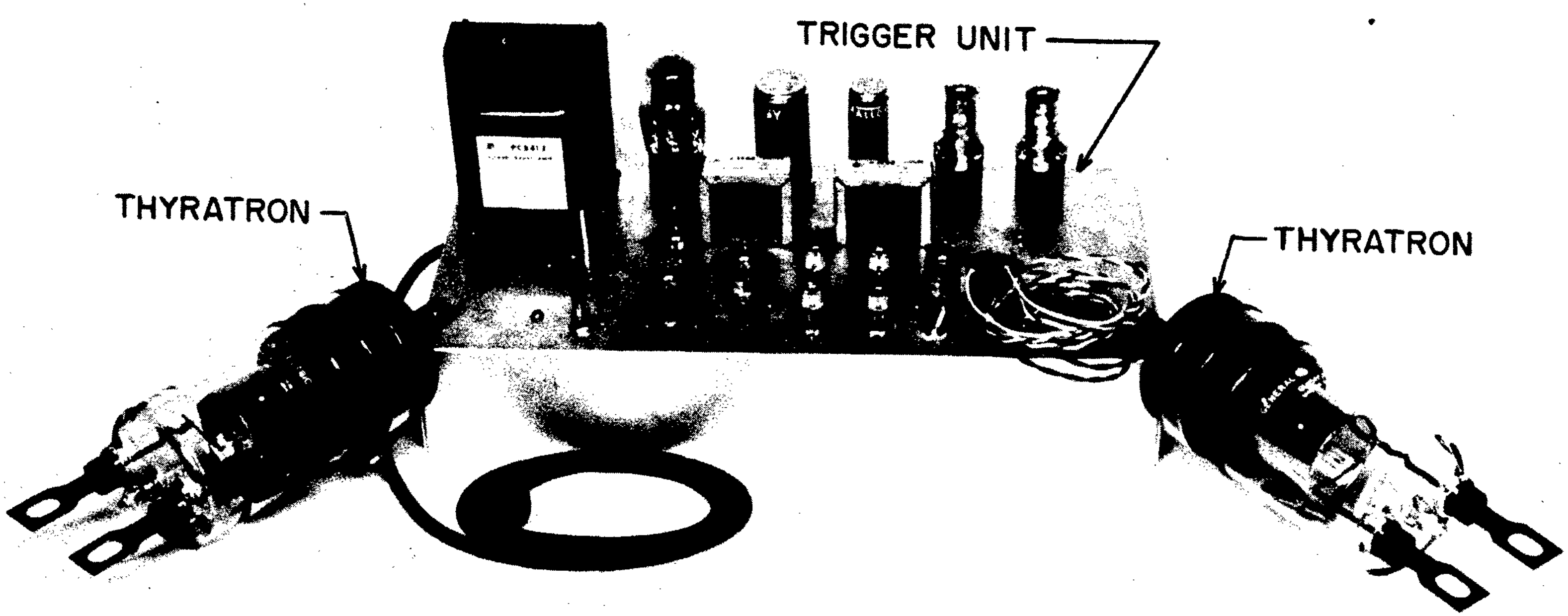

Fig. 3. Trigger unit.

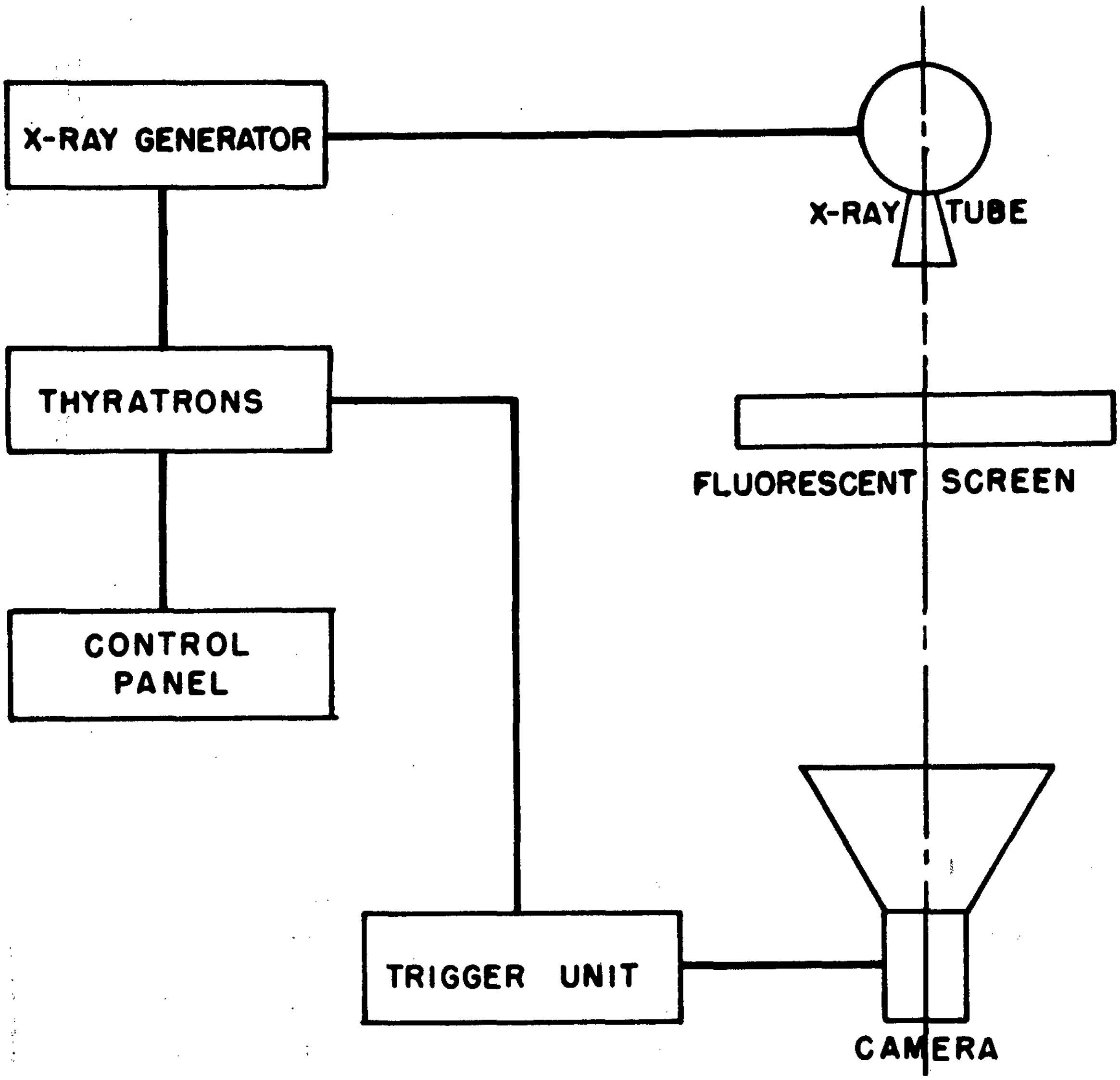

Fig. 4. Block diagram of USAMRL cinefluorographic unit.

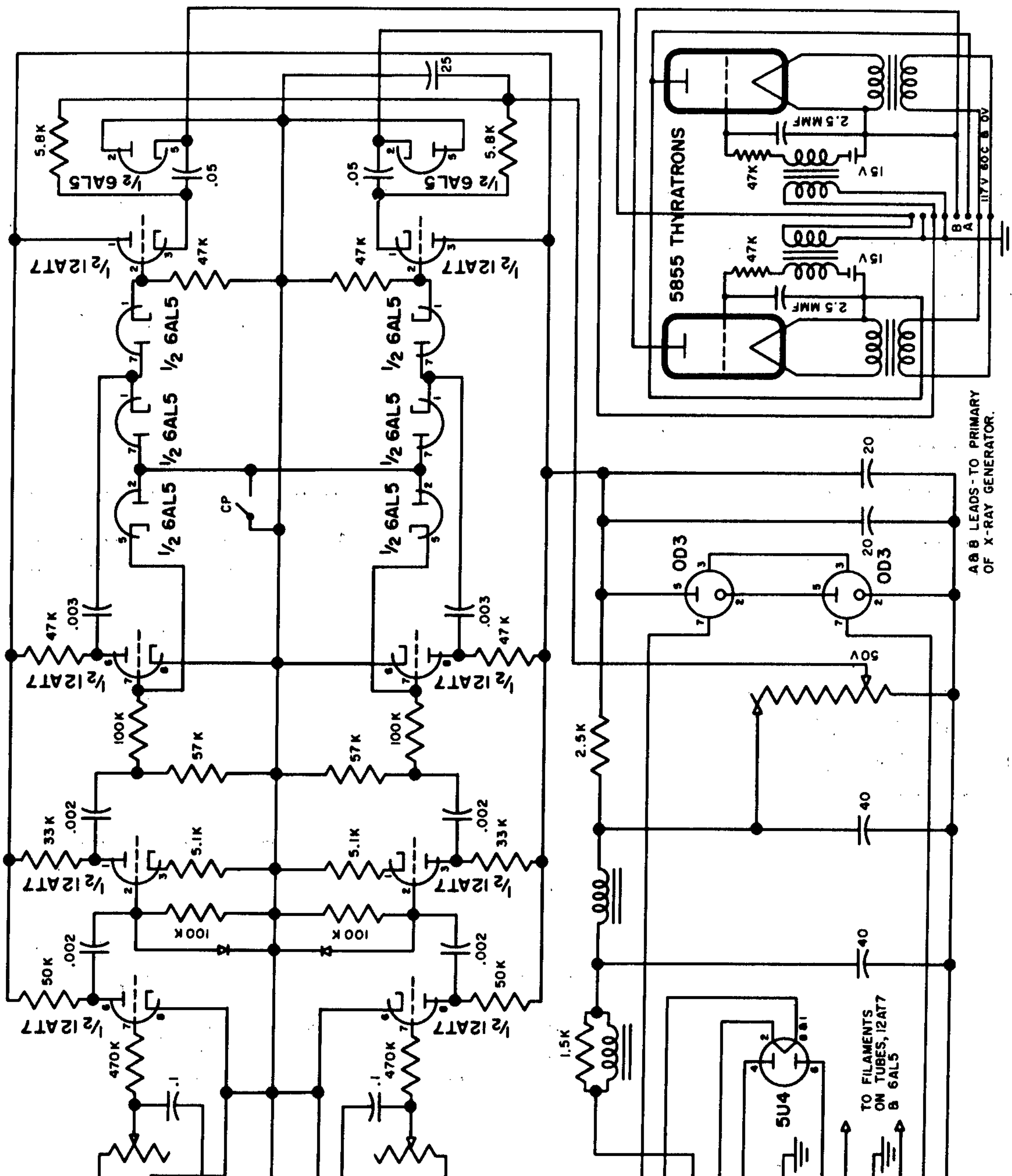

Fig. 5. Schematic of trigger unit showing thyratrons.

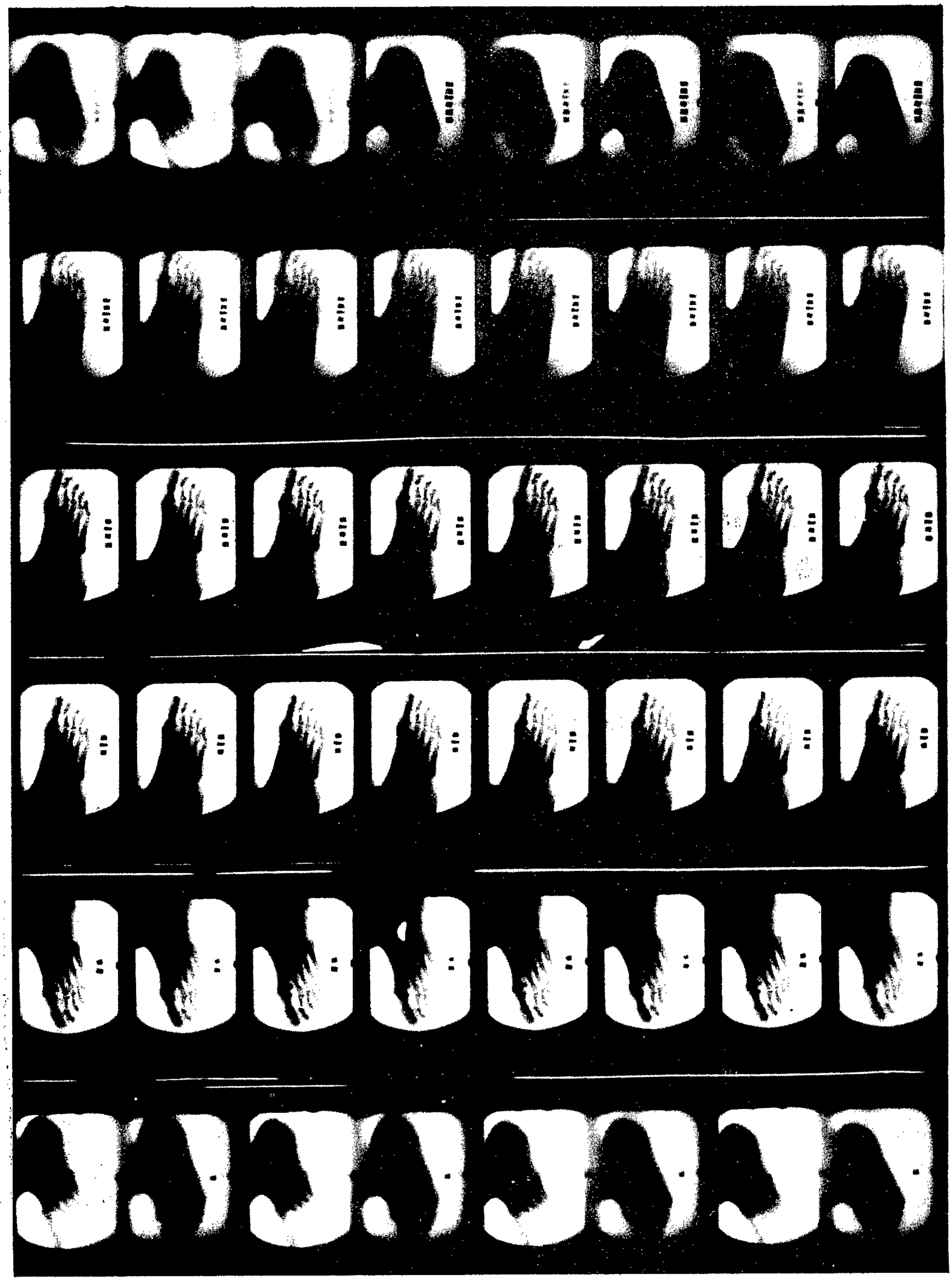

Fig. 6. Cinefluorographs obtained with various cam positions.

Fig. 7. Cinefluorographs of human foot, foot with shoe on, and mouse.